Claims

We Claim:

1. A particulate compound for modifying a characteristic of a fluid, comprising:
a core comprising the compound selected from the group consisting of:
polymers formed within a shell;
monomers which are polymerized within the shell, where the shell is inert to monomer polymerization; and
the shell encapsulating the core,
where the encapsulated compound is ground to form the particulate compound.

2. The particulate compound of claim 1 where the compound is a drag reducing agent that modifies the flow resistance of the fluid.

3. The particulate compound of claim 1 where the greatest outside dimension thereof is about 1000 microns or less.

4. The particulate compound of claim 1 where the encapsulated compound is ground by a method selected from the group consisting of cryogenic grinding, pressure grinding, and combinations thereof.

5. The particulate compound of claim 1 further comprising a coating of an anti-agglomeration agent applied during and/or after the encapsulated compound is ground.

6. The particulate compound of claim 1 where the polymers formed within the shell are formed from alpha-olefins and the monomers are alpha-olefins.

7. The particulate compound of claim 1 where the shell is selected from the group of materials consisting of polybutylene, polymethacrylates, waxes, polyethylene glycol (PEG), polypropylene glycol (PPG), alkoxyl terminated PEG, polyethyl-

ene oxide (PEO), polypropylene oxide (PPO), stearic acid, polyethylene waxes, and mixtures thereof.

8. An encapsulated compound for modifying a characteristic of a fluid, comprising:

a core comprising the compound selected from the group consisting of:

polymers formed within a shell;

monomers that are polymerized within the shell, where the shell is inert to monomer polymerization;

a barrier layer between the shell and the core; and

the shell encapsulating the barrier layer and the core, where the shell is different from the barrier layer.

9. The encapsulated compound of claim 8 where the compound is a drag reducing agent that modifies the flow resistance of the fluid.

10. The encapsulated compound of claim 8 where the polymers formed within the shell are formed from alpha-olefins and the monomers are alpha-olefins.

11. The encapsulated compound of claim 8 where the barrier layer is selected from the group consisting of polybutenes, polybutylenes, polymethacrylates, polyethylene glycol (PEG), polypropylene glycol (PPG), alkoxyl terminated PEG, polyethylene oxide (PEO), polypropylene oxide (PPO), stearic acid, polyethylene waxes, paraffin waxes and mixtures thereof, except that the barrier layer is not the same as the shell.

12. The encapsulated compound of claim 8 where the shell is selected from the group of materials consisting of polybutylene, polymethacrylates, polyethylene glycol (PEG), polypropylene glycol (PPG), alkoxyl terminated PEG, polyethylene oxide (PEO), polypropylene oxide (PPO), stearic acid, polyethylene waxes, paraffin

waxes and mixtures thereof, except that the shell is not the same as the barrier layer.

13. An encapsulated drag reducing agent (EDRA) for reducing drag in a liquid stream comprising:

a core reaction material comprising a monomer and a pre-polymerized catalyst; and

a shell encapsulating the core reaction material, where the shell is inert to the monomer polymerization;

where the monomer is polymerized within the shell.

14. The EDRA of claim 13 where the monomer is an alpha-olefin.

15. The EDRA of claim 13 where the core reaction material has an absence of solvent for the monomer.

16. The EDRA of claim 13 where the monomer is an alpha-olefin, and the catalyst is a Ziegler-Natta catalyst.

17. An encapsulated compound for modifying a characteristic of a fluid, comprising:

a core comprising the compound selected from the group consisting of:

polymers formed within the shell;

monomers which are polymerized within the shell, where the shell is inert to monomer polymerization; and

a shell encapsulating the core, where the shell contains polyethylene oxide of a molecular weight equal to or greater than 100,000 molecular weight where the polyethylene oxide forms a skin over the outer surface thereof.

18. The encapsulated compound of claim 17 where the compound is a drag reducing agent that modifies the flow resistance of the fluid.

19. The encapsulated compound of claim 17 where the polymers formed within the shell are formed from alpha-olefins and the monomers are alpha-olefins.

20. The encapsulated compound of claim 17 where the polyethylene oxide forms a skin over the outer surface of the shell in combination with a material selected from the group consisting of polyethylene glycols, alkoxypolyethylene derivatives, and mixtures thereof.

21. An encapsulated compound for modifying a characteristic of a fluid, comprising:

a core comprising the compound selected from the group consisting of:

polymers formed within the shell;

monomers which are polymerized within the shell, where the shell is inert to monomer polymerization; and

a shell encapsulating the core, where materials forming the shell have at least a portion of water therein removed by a method selected from the group consisting of vacuum stripping, molecular sieves, and combinations thereof.

22. The encapsulated compound of claim 21 where the compound is a drag reducing agent that modifies the flow resistance of the fluid.

23. The encapsulated compound of claim 21 where the polymers formed within the shell are formed from alpha-olefins and the monomers are alpha-olefins.

24. The encapsulated compound of claim 21 where the shell is selected from the group of materials consisting of polybutylene, polymethacrylates, polyethylene glycol (PEG), polypropylene glycol (PPG), alkoxyl terminated PEG, polyethylene

oxide (PEO), polypropylene oxide (PPO), stearic acid, polyethylene waxes, paraffin waxes and mixtures thereof.

25. A blend of drag reducing agents comprising:
at least one encapsulated compound comprising:
a core comprising the compound selected from the group consisting of:
polymers formed within the shell;
monomers which are polymerized within the shell, where the shell is inert to monomer polymerization; and
a shell encapsulating the core to produce an encapsulated drag reducing agent (EDRA); and
a second drag reducing agent produced by a process comprising:
providing a slurry of drag reducing polymer particles in a liquid which is a non-solvent for the polymer particles; and
removing at least a portion of the non-solvent liquid.

26. The blend of drag reducing agents of claim 25 where in the second drag reducing agent the slurry comprises from about 5% to 25% polymer.

27. The blend of drag reducing agents of claim 25 where the polymer for both the EDRA and the second drag reducing agent are the same or different polyalpha-olefin.

28. The blend of drag reducing agents of claim 25 where the shell of the EDRA is selected from the group of materials consisting of polybutylene, polymethacrylates, polyethylene glycol (PEG), methoxylated PEG, polyethylene oxide, stearic acid, paraffin waxes, polyethylene waxes and mixtures thereof.

29. An encapsulated compound for modifying a characteristic of a fluid, comprising:

a core comprising the compound selected from the group consisting of:
polymers formed within a shell;
monomers that are polymerized within the shell, where the shell is inert to monomer polymerization;
where the polymerization of the monomers to form the polymers is accomplished by a main catalyst, which cannot catalyze the polymerization of the monomers until a co-catalyst is added thereto;
a co-catalyst in the core; and
the shell encapsulating the core.

30. The encapsulated compound of claim 29 where the main catalyst is selected from the group consisting of aluminum activated titanium trichloride, titanium tetrachloride, and mixtures thereof and the co-catalyst is selected from the group consisting of diethylaluminum chloride, diethylaluminum bromide, diethylaluminum iodide, dipropylaluminum chloride, dibutylaluminum chloride, ethylpropyl aluminum chloride, ethylene dichloride, diethylaluminum ethoxide, dimethylaluminum ethoxide, diethylaluminum propoxide, ethylmethylaluminum ethoxide, isobutyl aluminoxane and mixtures thereof.

31. The encapsulated compound of claim 29 where the compound is a drag reducing agent that modifies the flow resistance of the fluid.

32. The encapsulated compound of claim 29 where the polymers formed within the shell are formed from alpha-olefins and the monomers are alpha-olefins.

33. A method for making a particulate compound for modifying a characteristic of a fluid, comprising:
encapsulating a core with a shell where the core comprises a compound made by a process selected from the group consisting of:
forming polymers within the shell;

polymerizing monomers within the shell, where the shell is inert to monomer polymerization; and

grinding the encapsulated compound to form the particulate compound.

34. The method of claim 33 where in encapsulating the core the compound is a drag reducing agent that modifies the flow resistance of the fluid.

35. The method of claim 33 where in grinding the encapsulated compound the greatest outside dimension of the particulate compound thereof is about 1000 microns or less.

36. The method of claim 33 where the grinding is conducted by a process selected from the group consisting of cryogenic grinding, pressure grinding, and combinations thereof.

37. The method of claim 33 further comprising coating the particulate compound with an anti-agglomeration agent during and/or after grinding the encapsulated compound.

38. The method of claim 33 where forming polymers within the shell and polymerizing monomers comprises polymerizing alpha-olefins.

39. The method compound of claim 33 where in encapsulating a core with a shell, the shell is selected from the group of materials consisting of polybutylene, polymethacrylates, waxes, polyethylene glycol (PEG), polypropylene glycol (PPG), alkoxyl terminated PEG, polyethylene oxide (PEO), polypropylene oxide (PPO), stearic acid, polyethylene waxes, and mixtures thereof.

40. A method for making an encapsulated compound for modifying a characteristic of a fluid, comprising:

forming a core within a shell comprising a technique selected from the group consisting of:

forming polymers within a shell;

polymerizing monomers within the shell,

where the shell is inert to monomer polymerization;

forming a barrier layer between the shell and the core; and

encapsulating the barrier layer and the core with the shell, where the shell is different from the barrier layer.

41. The method of claim 40 where in forming the core, the core comprises a drag reducing agent that modifies the flow resistance of the fluid.

42. The method of claim 40 where in forming the polymers within the shell and polymerizing the monomers comprise polymerizing alpha-olefins.

43. The method of claim 40 where in forming the barrier layer, the barrier layer is selected from the group consisting of polybutenes, polybutylenes, polymethacrylates, polyethylene glycol (PEG), polypropylene glycol (PPG), alkoxyl terminated PEG, polyethylene oxide (PEO), polypropylene oxide (PPO), stearic acid, paraffin waxes, polyethylene waxes, and mixtures thereof, except that the barrier layer is not the same as the shell.

44. The method of claim 40 where in forming a core within the shell, the shell is selected from the group of materials consisting of polybutylene, polymethacrylates, polyethylene glycol (PEG), polypropylene glycol (PPG), alkoxyl terminated PEG, polyethylene oxide (PEO), polypropylene oxide (PPO), stearic acid, paraffin waxes, polyethylene waxes, and mixtures thereof, except that the shell is not the same as the barrier layer.

45. A method of making an encapsulated drag reducing agent (EDRA) for reducing drag in a liquid stream comprising:

providing a core reaction material comprising a monomer and a pre-polymerized catalyst;

encapsulating the core reaction material in a shell, where the shell is inert to the monomer polymerization; and

polymerizing the monomer within the shell.

46. The method of claim 45 where in providing the core reaction material, the monomer is an alpha-olefin.

47. The method of claim 45 where in providing the core reaction material, the core reaction material has an absence of solvent for the monomer.

48. The method of claim 45 where in providing the core reaction material, the monomer is an alpha-olefin, and the catalyst is a Ziegler-Natta catalyst.

49. A method for making an encapsulated compound for modifying a characteristic of a fluid, comprising:

providing a core comprising the compound selected from the group consisting of:

forming polymers within the shell;

polymerizing monomers which are within the shell,

where the shell is inert to monomer polymerization; and

encapsulating the core with a shell, where the shell contains polyethylene oxide of a molecular weight equal to or greater than 100,000 molecular weight where the polyethylene oxide forms a skin over the outer surface thereof.

50. The method of claim 48 where in providing a core, the compound is a drag reducing agent that modifies the flow resistance of the fluid.

51. The method of claim 49 where in providing a core, forming the polymers within the shell and polymerizing the monomers comprise polymerizing alpha-olefins.

52. The method of claim 49 where in encapsulating the core, the skin forms over the outer surface of the shell in combination with a material selected from the group consisting of polyethylene glycols, alkoxypolyethylene derivatives, and mixtures thereof.

53. A method of making encapsulated compounds for modifying a characteristic of a fluid, comprising:

providing a core comprising the compound made by a process selected from the group consisting of:

forming polymers within the shell;

polymerizing monomers within the shell,

where the shell is inert to monomer polymerization; and

encapsulating the core with a shell, including removing at least a portion of water from the shell by a method selected from the group consisting of vacuum stripping, molecular sieves, and combinations thereof.

54. The method of claim 53 where in providing the core the compound is a drag reducing agent that modifies the flow resistance of the fluid.

55. The method of claim 53 where in forming polymers within the shell comprise forming polymers from alpha-olefins and polymerizing monomers comprises alpha-olefins.

56. The method of claim 53 where in encapsulating the core with a shell, the shell is selected from the group of materials consisting of polybutylene, polymeth-acrylates, polyethylene glycol (PEG), polypropylene glycol (PPG), alkoxyl termi-

nated PEG, polyethylene oxide (PEO), polypropylene oxide (PPO), stearic acid, paraffin waxes, polyethylene waxes, and mixtures thereof.

57. A method of making a blend of drag reducing agents comprising:
providing at least one encapsulated compound comprising:
providing a core by a method selected from the group consisting of:
forming polymers within the shell;
polymerizing monomers which are within the shell,
where the shell is inert to monomer polymerization; and
encapsulating the core with a shell to produce an encapsulated drag reducing agent (EDRA); and
providing a second drag reducing agent produced by a process comprising:
providing a slurry of drag reducing polymer particles in a liquid which is a non-solvent for the polymer particles; and
removing at least a portion of the non-solvent liquid.

58. The method of claim 57 where in providing the secondary drag reducing agent, the second drag reducing agent the slurry comprises from about 5 to 25% polymer.

59. The method of claim 57 where the polymer for both the EDRA and the second drag reducing agent are the same or different polyalpha-olefin.

60. The method of claim 57 where in providing the at least one encapsulated compound, the shell of the EDRA is selected from the group of materials consisting of polybutylene, polymethacrylates, polyethylene glycol (PEG), methoxylated PEG, polyethylene oxide, stearic acid, paraffin waxes, polyethylene waxes and mixtures thereof.

61. A method of making an encapsulated compound for modifying a characteristic of a fluid, comprising:

providing a core comprising the compound made by a method selected from the group consisting of:

forming polymers within a shell;

polymerizing monomers within the shell,

where the shell is inert to monomer polymerization and where the polymerization of the monomers to form the polymers is accomplished by a main catalyst which cannot catalyze the polymerization of the monomers until a co-catalyst is added thereto;

adding a co-catalyst to the monomers; and

encapsulating the core with the shell.

62. The method of claim 61 where in providing the core the main catalyst is selected from the group consisting of aluminum activated titanium trichloride, titanium tetrachloride, and mixtures thereof and the co-catalyst is selected from the group consisting of diethylaluminum chloride, diethylaluminum bromide, diethylaluminum iodide, dipropylaluminum chloride, dibutylaluminum chloride, ethylpropyl aluminum chloride, ethylene dichloride, diethylaluminum ethoxide, dimethylaluminum ethoxide, diethylaluminum propoxide, ethylmethylaluminum ethoxide, isobutyl aluminoxane and mixtures thereof.

63. The method of claim 61 where in providing the core the compound is a drag reducing agent that modifies the flow resistance of the fluid.

64. The method of claim 61 where in providing the core, forming the polymers within the shell comprises forming polymers from alpha-olefins and polymerizing monomers comprises polymerizing alpha-olefins.

65. A method for making a particulate compound for modifying a characteristic of a fluid, comprising:

encapsulating a core with a shell where the core comprises a compound made by a process selected from the group consisting of:

forming polymers within the shell;

polymerizing monomers within the shell, where the shell is inert to monomer polymerization, and where the shell has an outer diameter of greater than 5000 microns; and

achieving a monomer conversion of greater than about 60%.

66. A method for making a particulate compound for modifying a characteristic of a fluid, comprising:

encapsulating a polyalpha-olefin core with a shell where the core comprises a compound made by a process selected from the group consisting of:

forming polyalpha-olefins within the shell;

polymerizing alpha-olefins within the shell, where the shell is inert to alpha-olefin polymerization; and

where the forming or polymerizing occurs in an absence of molecular oxygen and hydroxyl groups.